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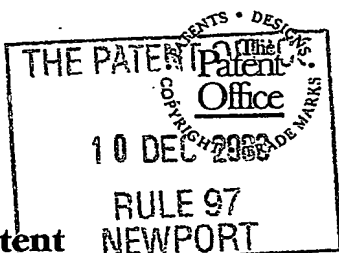
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11DEC03 E858654-1.669640  
P01/7700 0.00-0328672.1 NONE

# Request for grant of a patent

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Cardiff Road  
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1. Your reference  
IB/jag

2. Patent application number  
(The Patent Office will fill this part in)

0328672.1

10 DEC 2003

3. Full name, address and postcode of the or of each applicant (underline all surnames)

Genome Research Ltd  
The Sanger Centre  
Wellcome Trust Genome Campus  
Hinxton  
Cambridge CB10 1SA

Patents ADP number (if you know it)

6438022002

If the applicant is a corporate body, give the country/state of its incorporation

GB

4. Title of the invention  
MODULAR UNITS

5. Name of your agent (if you have one)

"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)

i.p. 21 Limited  
Norwich Research Park  
Colney  
NORWICH  
NR4 7UT  
United Kingdom (GB)

Patents ADP number (if you know it)

8060758001

6. Priority: Complete this section if you are declaring priority from one or more earlier patent applications, filed in the last 12 months.

Country

Priority application number  
(if you know it)

Date of filing  
(day / month / year)

7. Divisionals, etc: Complete this section only if this application is a divisional application or resulted from an entitlement dispute (see note f)

Number of earlier UK application

Date of filing  
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8. Is a Patents Form 7/77 (Statement of inventorship and of right to grant of a patent) required in support of this request?

Answer YES if:

- a) any applicant named in part 3 is not an inventor, or
- b) there is an inventor who is not named as an applicant, or
- c) any named applicant is a corporate body.

Otherwise answer NO (See note d)

YES

## Patents Form 1/77

9. Accompanying documents: A patent application must include a description of the invention. Not counting duplicates, please enter the number of pages of each item accompanying this form:

Continuation sheets of this form 0

Description 11

Claim(s) 2 *D*

Abstract 0

Drawing(s) 9+9

10. If you are also filing any of the following, state how many against each item.

Priority documents

Translations of priority documents

Statement of inventorship and right to grant of a patent (Patents Form 7/77)

Request for a preliminary examination and search (Patents Form 9/77)

Request for a substantive examination (Patents Form 10/77)

Any other documents (please specify)

11. I/We request the grant of a patent on the basis of this application.

Signature(s)

*ip21 Limited by IB* Date 9/12/2003

12. Name, daytime telephone number and e-mail address, if any, of person to contact in the United Kingdom

01603 457008

ianbishop@ip21.co.uk

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- 1 -

## MODULAR UNITS

### Field of the Invention

15

The invention relates to modular units for transporting work pieces and suitable for use in an array of such units. The invention also relates to arrays of modular units for transporting work pieces.

20 The invention will have particular applications in the following fields:

- Genetics;
- Manufacture, for example printed circuit boards (PCB) or similar electronic components;
- 25 • Package sorting/handling;
- Other appropriate automated processing systems.

### Background to the Invention and Prior Art known to the Applicants

30 Broadly, known transportation systems are either conveyor-based systems or gripper-based systems. Work pieces transported for processing in traditional systems are usually placed beneath or on top of processing devices. For top side processing such as liquid handling, a conventional conveyor system may be employed whilst for thermocycling for

example a gripper-based system may be employed to place the work piece either on top or within a thermo-cycling device.

5 In traditional conveyor-based systems, it is not possible to treat a work piece from below or simultaneously from above and below a work piece without removing the work piece from the transportation system. Typically, a gripper-based mechanism must be used to first remove the plate from the conveyor and then place it on to a dedicated processing station.

10 One of the objectives of the present invention is to provide a modular unit which facilitates the transportation of work pieces whilst allowing their treatment, either from below, simultaneously from above and below or even from above only, without having to remove them from the modular unit.

15 A further objective of the invention is to present an innovative way to transport work pieces in an X and Y plane.

A further objective of the invention is to provide a modular unit which allows the removal of work pieces from the top of the unit to allow the continuation of the transport of work  
20 pieces whilst a work piece is lifted.

A further general objective is to provide an array of modular units under improved control systems to allow a more efficient multi-discipline processing of units.

25 The following patent applications constitute the prior art known to the applicants:

- US6068393 (Zymark);
- US6374989 (Bayer);
- US2002/0102149 (Tek Cel);
- 30 • WO02/49761/A2 (Protedyne);
- US4850472 (GMN)

The present invention distinguishes itself, from the general background of the art discussed above and the specific patent references, by the features detailed in the following section.

5    Summary of the Invention

In its broadest aspect, the invention provides a modular unit for transporting work pieces and suitable for use in an array of such units, comprising a top; transportation means which propel the work pieces onto and/or off said top and against which the work pieces  
10    rest when located on the top of the unit, the transportation means being part of said top; in which the transportation means occupy one or more regions of the top of the unit whilst one or more remaining regions of the top are not occupied by transportation means but are suitable for receiving a work piece treatment device.

15    This configuration of features is particularly advantageous because it allows treatment from below the work piece and from above and below alongside the transportation system. It is also particularly advantageous because it allows considerable savings of time and space in automating complex processes that typically include a succession of different processes to be applied to the work pieces. By minimising the requirement of removing  
20    the work pieces from the top, it allows for more efficient processing. It is also particularly beneficial in terms of its achievable compactness and flexibility.

In a subsidiary aspect in accordance with the invention's broadest aspect, the transportation means are located substantially about the periphery of the top and the  
25    region of the top of the unit located within the periphery of the top is suitable for receiving a work piece treatment device.

This configuration is particularly beneficial because it allows the stable propelling of work pieces whilst achieving improved work piece treatment. It will be particularly  
30    beneficial in terms of allowing the work piece to be treated from below without requiring the work piece gripped and lifted onto a specific work piece treatment device for treating from below the work piece.

In a further subsidiary aspect, the transportation means comprise a wheel, a drive causing the wheel to rotate and means to selectively engage the wheel with a work piece when a work piece is located on top of the unit.

- 5 This additional combination of features would allow the unit to be controlled in order to displace a work piece in a given direction or not to direct the work piece in that direction should the modular unit be controlled not to displace the work piece in that manner.

10 In a further subsidiary aspect, the unit comprises at least one wheel for driving the work piece in one direction and at least one second wheel which selectively engages the work piece and is oriented, in use, in a second direction.

15 One of the advantages of this configuration would be to allow the work piece to be readily displaced from one line of action to another without requiring the typical lifting and rotating of the work piece itself.

20 In a further subsidiary aspect, the unit's at least one second wheel not only engages the work piece but is adapted to lift the work piece so that the work piece only engages the second wheel.

25 This would allow the second wheel to exclusively control, in one mode of operation, the direction in which the work piece is to be displaced. In this configuration, the rotation of the first wheel set would cease to propel the work piece. This may allow the rotation of the first wheel set to freely continue during the actuation of the second wheel set.

30 In a further subsidiary aspect, the units at least one wheel and the unit's at least one second wheel are orthogonal one relative to the other. This is particularly advantageous because it allows the work piece's line of displacement to be readily changed without requiring the rotation of the work piece itself.

In a further subsidiary aspect, the unit comprises two compartments: one for receiving a work piece treatment device located in an upper compartment of the unit and a second

containing the control electronics; and a separating member is provided to seal the second compartment from the first compartment.

5 This has particular benefits when the upper compartment for example is cleaned using a substance which would otherwise damage the control electronics.

In a further subsidiary aspect, work piece lifting means are provided to lift the work piece, the lifting means being sufficiently spaced to allow the transportation means to continue to transport work pieces whilst lifting one work piece.

10

In a further subsidiary aspect, the invention provides an array of modular units wherein the units are each in accordance with any of the preceding aspects and of substantially equal height and control means are provided to control the displacement in the X and Y plane from one unit to another.

15

When the modular units are placed in an array of modular units in this manner, the advantages as to flexibility and compactness of the system are emphasised.

20 In a further subsidiary aspect, each unit's control means allows the direct communication from one unit to its direct neighbouring units, whereby the transportation from one unit to the next may be co-ordinated.

25 In a further subsidiary aspect, a further array of modular units is suspended above the units comprising work piece treatment devices. This configuration would allow improved treatment of work pieces from both above and below the work pieces.

30 In a further subsidiary aspect, the control means stores a number of operative protocols depending on work piece types, selects the appropriate operative protocol dependent on the work piece to instruct the operation of a series of units, and scheduling means are provided, whereby several protocols may run in parallel in the array of modular units.

This configuration of features would allow optimal operation of a multi-task modular array of units.



allowing a number of wheels such as that referenced 10 to protrude from the plate in order to be able to engage a work piece for propelling the work piece onto and/or off the top of this modular unit. Two sets of wheels are provided in this modular unit, each being oriented in the same direction and being spaced apart from one another and located generally on the periphery of the top plate 5. The space provided between the two sets of wheels may be suitable for incorporating a work piece treatment device. Further cut-outs such as that referenced 11 are provided in the top plate 5, each of which accommodates an idle wheel such as that referenced 12 designed to prevent work pieces jamming between modular units if used in an array of such units.

Lower compartment 3 incorporates part of the control means of the modular unit. The control means may comprise electronic control means 13 and a motor 14 which may be selected by the person skilled in the art to control the periodic motion of the sets of wheels of the top plate of the modular unit. Legs such as that referenced 15 are provided whose length is selected to allow sufficient clearance between the lower compartment 3 of the unit and the ground. The legs may also be placed at a sufficient distance from the motor to allow air flow for cooling purposes. Other apertures in the plates such as that referenced 16 may be provided to allow the releasable attachment of say a drive mechanism or other work piece treatment device within the upper compartment of the unit.

Figure 2 shows an inside perspective view of modular unit 1. The two sets of wheels generally referenced 17 and 18 are illustrated alongside their respective drive belts 19 and 20 which drive the rotation of the wheel sets when actuated upon by the motor 14. A constant force spring 21 is also provided to maintain the drive belt in tension for correct transmission of rotation to the wheels. As can be seen, the wheel sets are so arranged at the periphery of the housing so that a relatively large empty space in a central region of the housing results which would be ideal to receive an appropriate work piece treatment device as selected by the person skilled in the art. This central region may also be occupied by a circuit board or a drive mechanism as appropriate.

A bottom plate 22 is provided and is part of the means to seal the lower compartment from the upper compartment of the unit. An enclosure 23 is also provided as part of the

means to seal the lower compartment from the upper compartment but is adapted specifically to allow, whilst providing sufficient sealing, the passage of the belt or belts. Several cut-outs such as that referenced 24 may also be provided in bottom plate 22 to allow supply lines to pass if required. The supply lines may include electricity conducting means, fluid conduits and optical transmitters. A couple of sensors located in opposite corners of the unit have been provided to detect the presence or absence of work pieces.

Figure 3 shows a second unit type generally referenced 27. This unit's line of action is in the Y direction, the unit may therefore be referred to as a Y modular unit. The periphery of this unit is similar to the periphery of unit 1 described in either Figures 1 or 2. The main difference is that it comprises two sets of wheels referenced 28 and 29 which are located at the periphery of the unit but along the shorter sides of the unit so that work piece may be propelled in the Y direction. The large empty space in this configuration can be clearly seen between set 28 and 29.

Figure 4 shows a modular unit generally referenced 30 comprising two sets of wheels 31 and 32 oriented in the general X direction and two further sets of wheels 33 and 34 are entered in the Y direction. The modular unit illustrated may therefore be referred to as an X and Y modular unit. Means are provided to lift wheel sets 33 and 34 so that they only engage a work piece whilst the wheel sets 31 and 32 are spaced from the work piece. This configuration would allow the displacement of a work piece from propulsion in the X direction to a mode of propulsion in the Y direction. The lift and drive mechanisms may be selected by the person skilled in the art from known alternatives and may occupy the central region of the modular unit.

Figure 5 shows a further modular unit generally referenced 35 which schematically illustrates an embodiment of a modular unit comprising at least one wheel which may selectively engage a work piece by lifting and lowering a wheel such as that referenced 36 and simultaneously providing means to rotate for example as indicated by arrow 37 in order to allow a single wheel or a set of wheels to displace a work piece along the top of the modular unit within the X and Y plane. The drive means and control means necessary to accomplish this function may be selected by the person skilled in the art from known alternatives.

Figure 6 shows a further modular unit generally referenced 38. An actuator 39 is shown protruding from the top of the unit and will be selected to be suitable for lifting a work piece such as that referenced 40. This embodiment allows other work pieces (not illustrated in the figure) to be propelled across the top surface of the modular unit whilst one or more work pieces are lifted out of the line of displacement of the propelled work pieces.

The modular units described above may be employed in an array of modular units where each unit is of substantially equal height. The term 'substantially equal height' is intended to be interpreted broadly and would for example allow fluctuations of say 10mm between neighbouring units to allow the ready passage of a work piece from one unit to the next. In this sense, an X modular unit may be 10mm lower than a Y modular unit whilst for an XY modular unit, the X propelling region would be 10mm lower than the Y propelling region when in propelling mode.

Figure 7 shows an array of the modular units generally referenced 41 associated with an array of further modular units suspended above modular units array 41 and generally referenced 42. The lower array of modular units 41 comprises a mixture of modular units for displacing work pieces 43 in the X direction such as that referenced 44 under a number of modular units for displacing work pieces in both the X and Y directions as appropriate such as that referenced 45. The array of above modular units may include a liquid injecting or aspirating head 46. Each head 46 may include a single nozzle or an array of nozzles corresponding to the array of cavities located in the work piece 43.

The invention also envisages that each individual nozzle head may be individually detachable from the array of nozzle heads so as to be itself modular. Means may be provided to allow the controlled displacement of head 46 from one location to another within the X and Y plane. Means may also be provided to displace the head in the Z direction as appropriate.

Figure 8 shows a further array of modular units generally referenced 47 where unit 48 and unit 49 incorporate in their top face respectively, a liquid bath 50 and a lighting unit 51 which allow a treatment of a work piece from below.

Means may be provided to pick any one of the work piece from the stack 52 and place the appropriate work piece on the top surface for treatment and propulsion to further units on this co-planar array. The co-planar array of this embodiment is particularly advantageous when the work pieces contain liquid biological samples in their open cavities.

The work piece treatment devices envisaged in this invention, in the context of analysis of biological material, may be from the group comprising:

- Liquid handling devices;
- Liquid supplying devices;
- Chemical baths;
- Apparatus for changing disposable tips;
- Removal devices;
- Mixers;
- Ultrasonic devices, particularly for cleaning;
- Optical measurement devices;
- Sensors of all kind;
- Heat exchangers for heating, maintaining a constant temperature and cooling samples;
- Devices for tilting work pieces;
- Devices for locating work pieces in a 3 dimensional position;
- Head changing device;
- Any other biological treatment device.

The control means for a typical multi-functional array of modular units of the kind illustrated in Figure 7 utilise processing means located at a central point which store a number of operative protocols dependent on a variety of work piece types. Dependent on whether for example the work piece is of a first kind of plate rather than a second kind of plate, the central processing means would trigger a series of operations to be carried out of a different kind by a variety of modular units. The processing means would also be adapted to establish, given the number of protocols operating simultaneously which

would be the best route to employ and in which order the operations should be carried out for maximum efficiency.

If for example two protocols operate simultaneously, the control means may coordinate the operation at one process step of both protocols. For example, the control means may coordinate one step of a first kind of protocol and one step of a second kind of protocol to achieve a coordinated copying operation.

Means may be provided to assess the operation of a given protocol which may result in the interruption of a protocol mid-course and the adoption of another protocol if certain pre-determined criteria are met.

The instructions from the processing means would be broadcast to each unit to trigger their response in terms of a pre-determined displacement or rotation of the wheel sets, if appropriate. It is envisaged that means will be provided to co-ordinate the displacement from one unit to the next by establishing a direct communication from one unit to its direct neighbouring units.

Figure 9 shows a further possible embodiment of the invention incorporating a further modular unit generally referenced 53 with a top surface 54. The top surface 54 incorporates a conveyor schematically illustrated in the figure and referenced 55 allowing the transportation of a work piece across the top of the unit. A region of the top surface is occupied by a work piece treatment device referenced 56 which may be equipped by say optical assessment means to assess a work piece when carried by the conveyor.

The scope of the invention is defined in the claims that follow.

CLAIMS

1. A modular unit for transporting work pieces and suitable for use in an array of such units, comprising a top; transportation means which propel the work pieces onto and/or  
5 off said top and against which the work pieces rest when located on the top of the unit, the transportation means being part of said top; in which the transportation means occupy one or more regions of the top of the unit whilst one or more remaining regions of the top are not occupied by transportation means but are suitable for receiving a work piece treatment device.
- 10 2. A modular unit according to claim 1, wherein the transportation means are located substantially about the periphery of the top and the region of the top of the unit located within the periphery of the top is suitable for receiving a work piece treatment device.
- 15 3. A modular unit according to either of the preceding claims, wherein the transportation means comprise a wheel, a drive causing the wheel to rotate, and means to selectively engage the wheel with a work piece, when a work piece is located on the top of the unit.
- 20 4. A modular unit according to any preceding claim, wherein the unit comprises at least one wheel for driving the work piece in one direction and at least one second wheel which selectively engages the work piece and is oriented, in use, in a second direction.
- 25 5. A modular unit according to claim 4, wherein the unit's at least one second wheel not only engages the work piece but is adapted to lift the work piece so that the work piece only engages the second wheel.
6. A modular unit according to either claim 4 or claim 5, wherein the unit's at least one wheel and the unit's at least one second wheel are orthogonal one relative to the other.
- 30 7. A modular unit according to claim 1, wherein the unit comprises two compartments: one for receiving a work piece treatment device located in an upper compartment of the unit and a second containing the control electronics; and a separating member is provided to seal the second compartment from the first compartment.

8. A modular unit according to any preceding claim, wherein work piece lifting means are provided to lift the work piece, the lifting means being sufficiently spaced to allow the transportation means to continue to transport work pieces whilst lifting one work piece.

5

9. An array of modular units, wherein the units are each in accordance with any of claims 1 to 8 and of substantially equal height and control means are provided to control the displacement in the X and Y plane from one unit to another.

10 10. An array of modular units according to claim 9, wherein each unit's control means allows the direct communication from one unit to its direct neighbouring units, whereby the transportation from one unit to the next may be coordinated.

11 11. An array of modular units according to claim 9, wherein a further array of modular units is suspended above the units comprising work piece treatment devices.

12. An array of modular units according to claims 9, 10 or 11, wherein the control means stores a number of operative protocols dependent on work piece types, selects the appropriate operative protocol dependent on the work piece to instruct the operation of a series of units, and scheduling means are provided, whereby several protocols may run in parallel in the array of modular units.

13. A modular unit or an array of modular units substantially as hereinbefore described with reference to and/or illustrated in any appropriate combination of the accompanying text and/or figures.

25

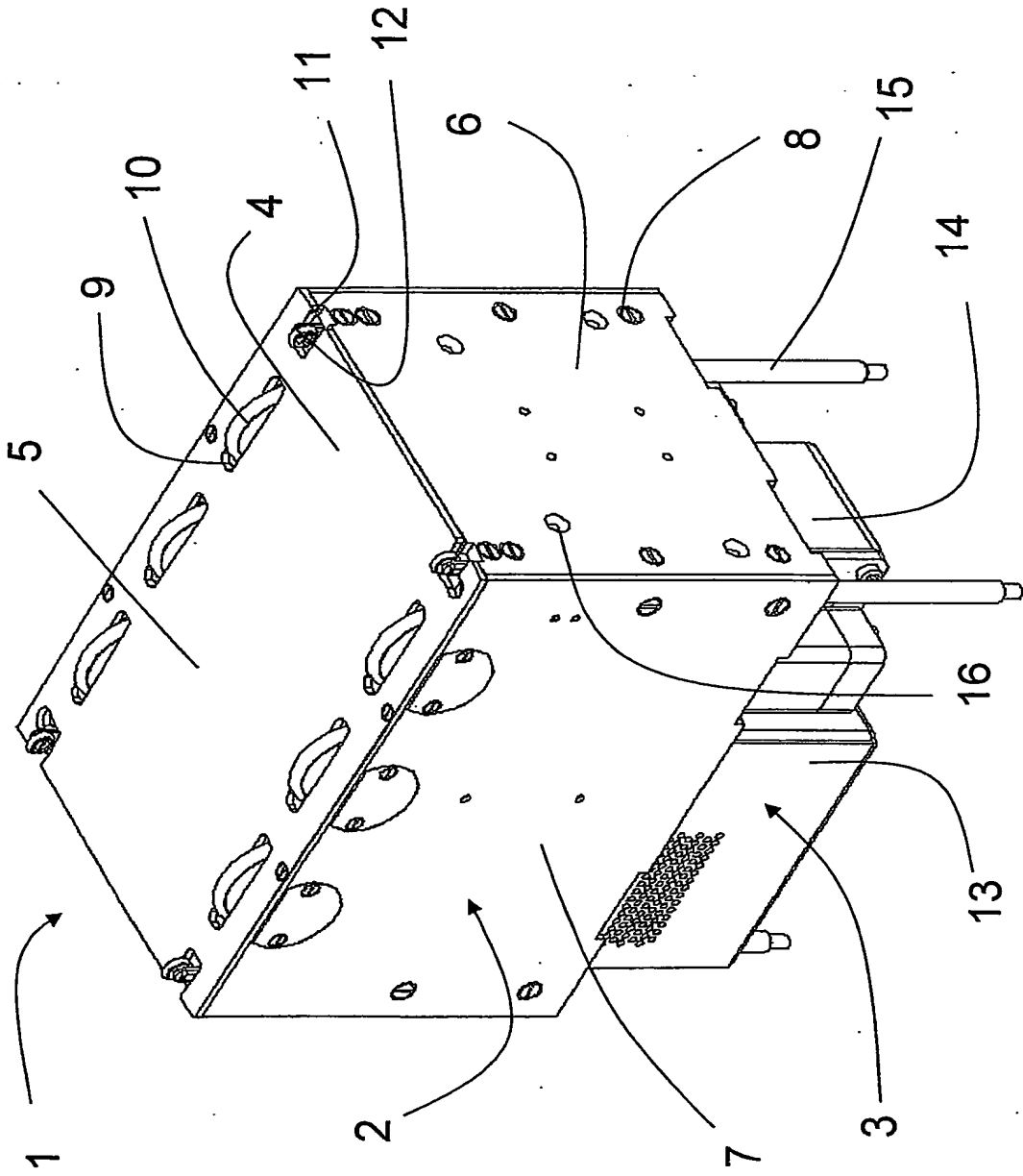


FIGURE 1



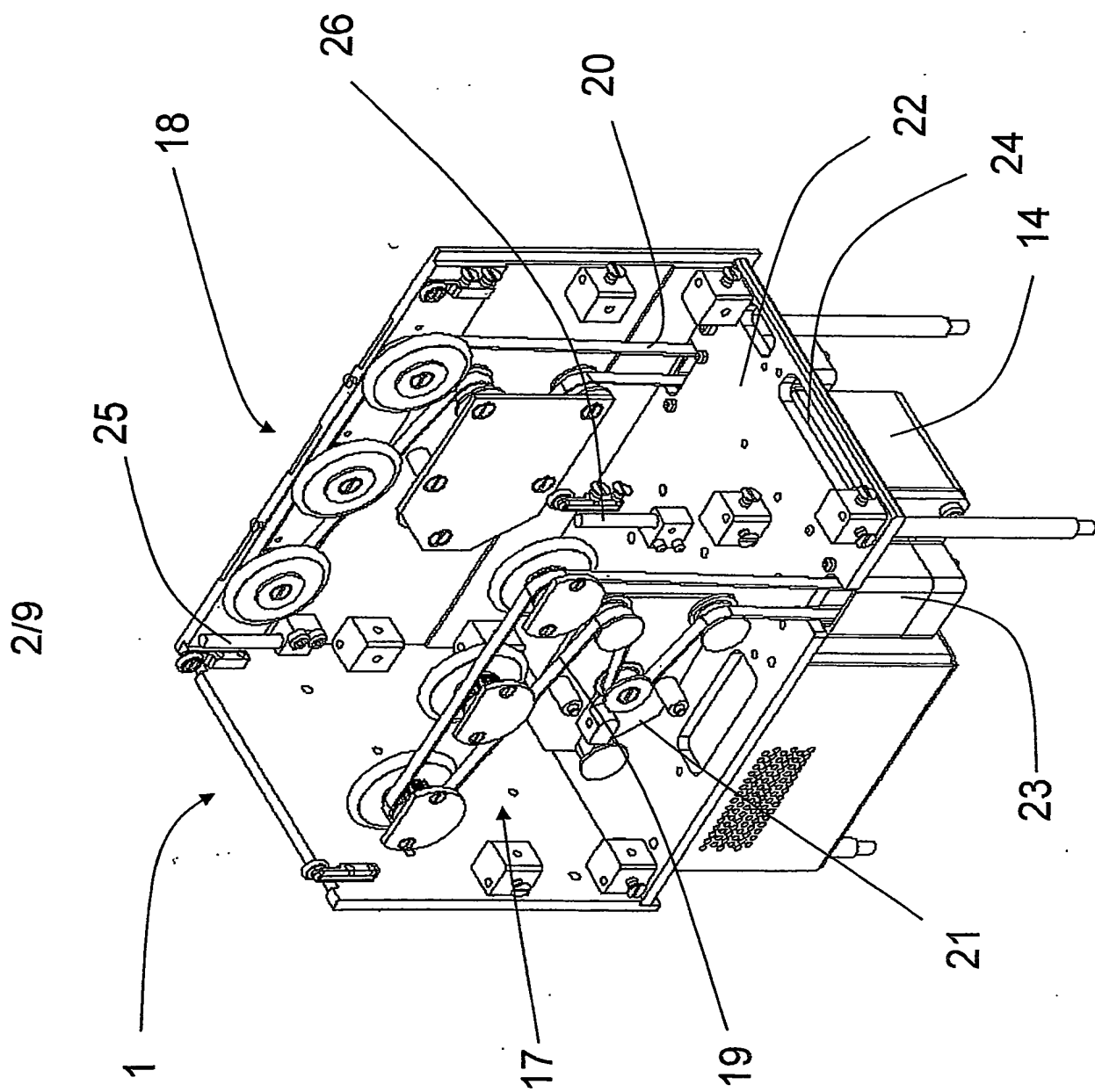


FIGURE 2

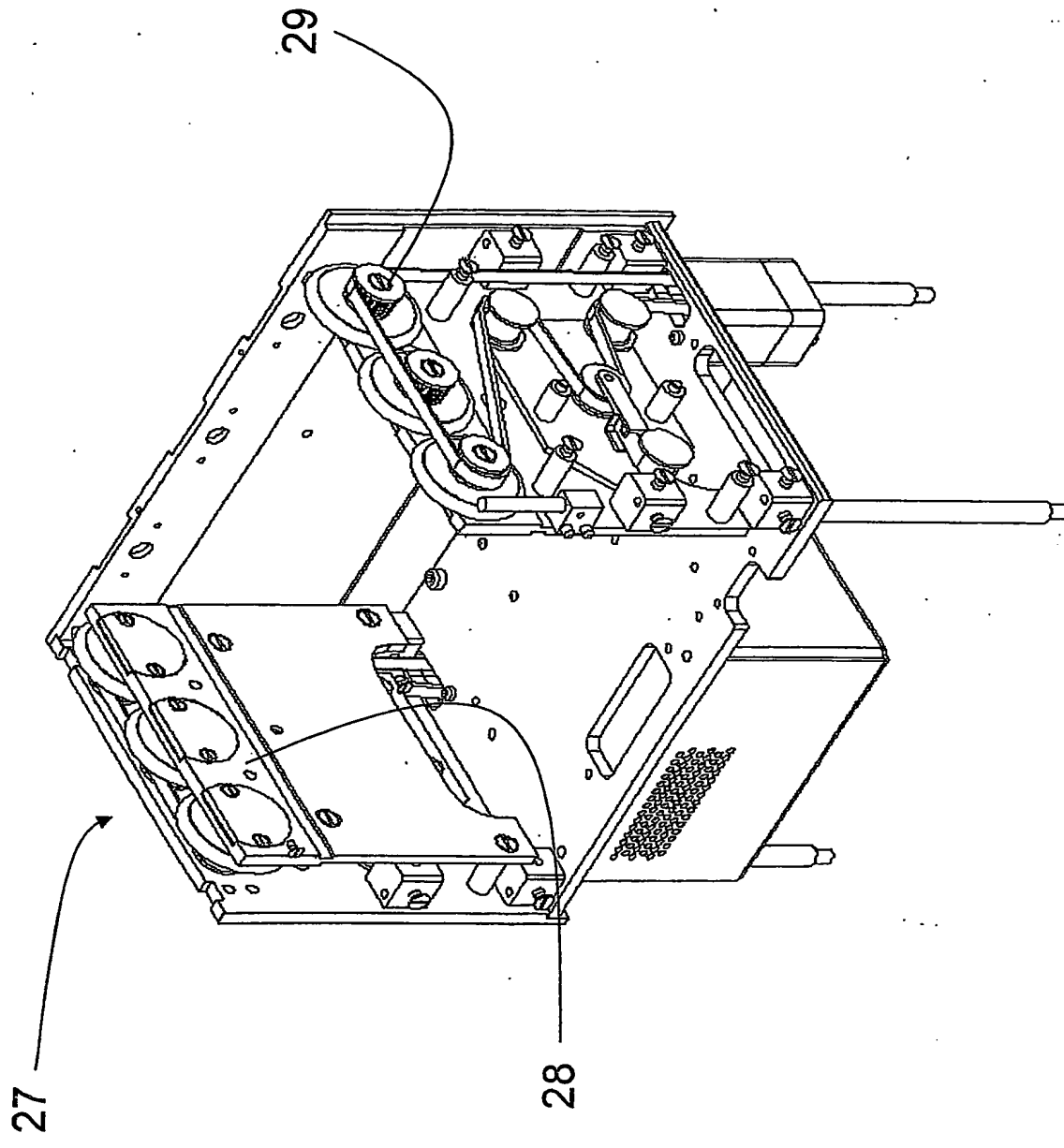
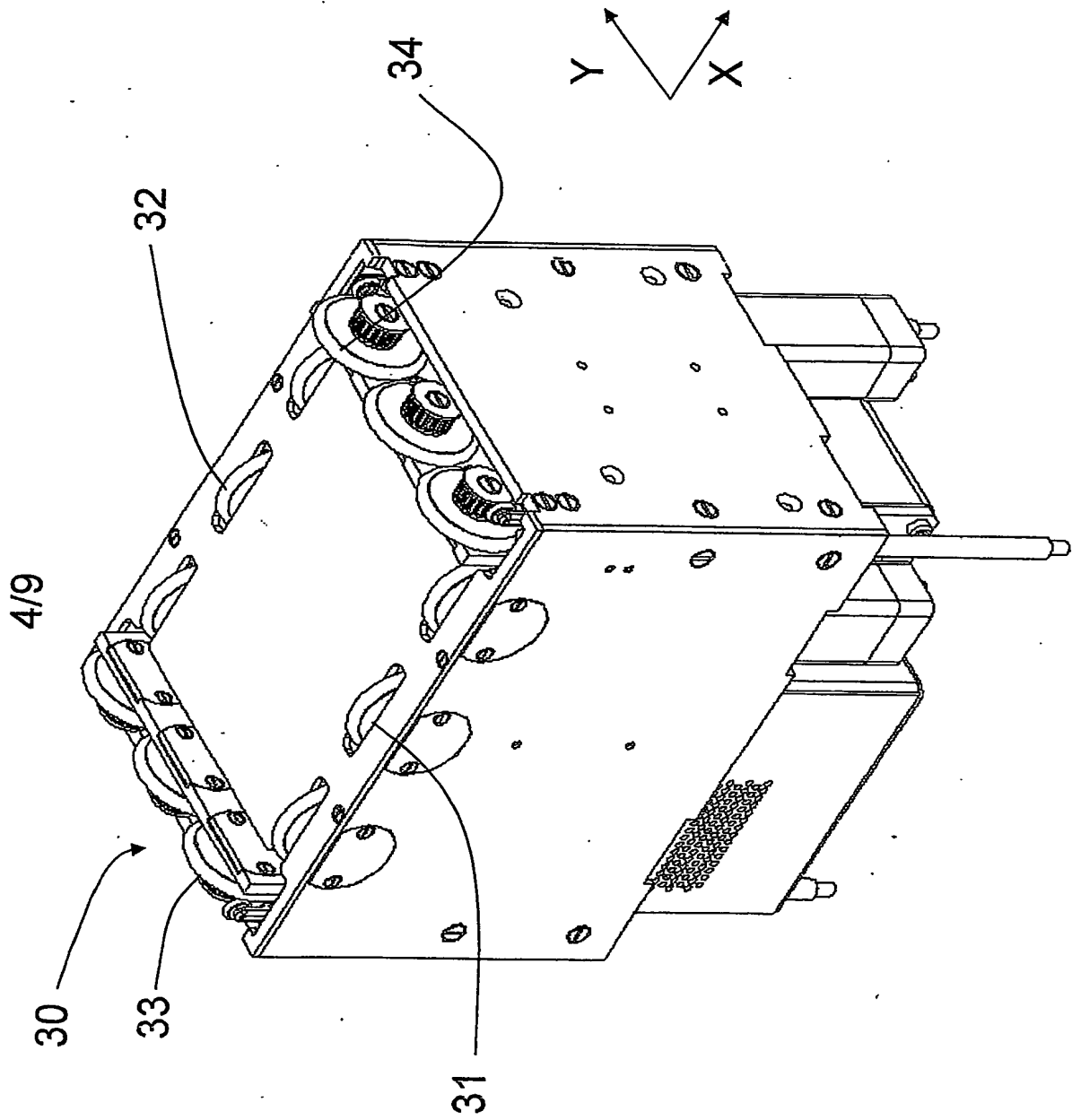


FIGURE 3



**FIGURE 4**

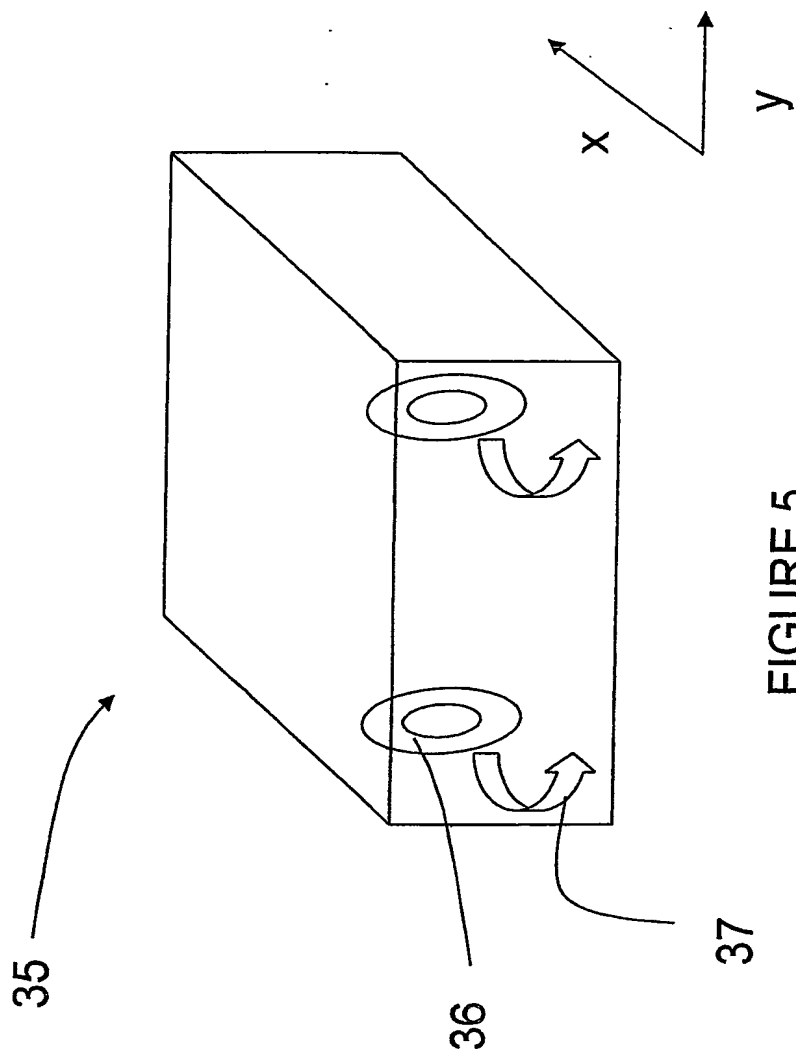


FIGURE 5

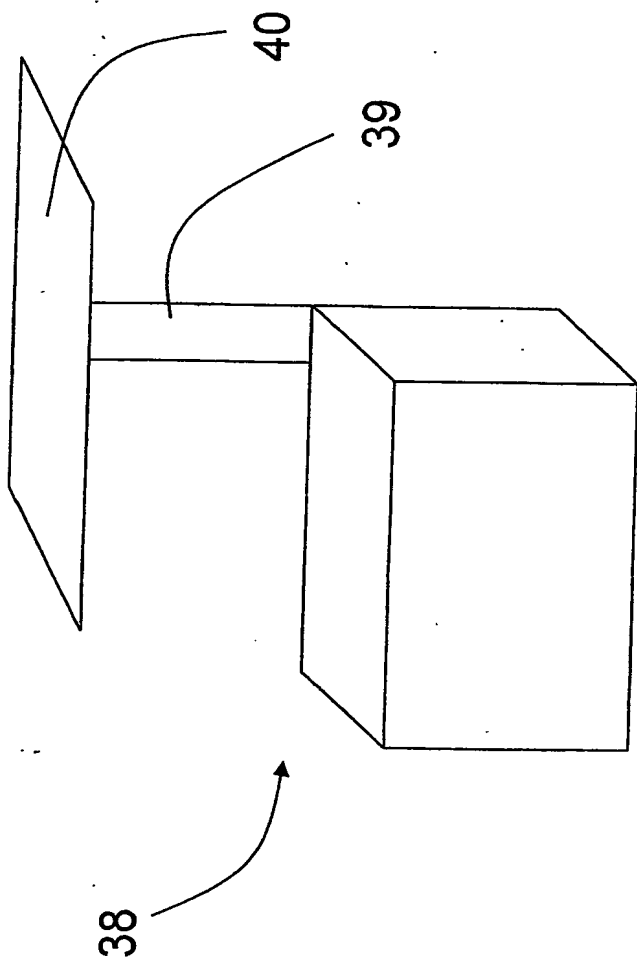


FIGURE 6

7/9

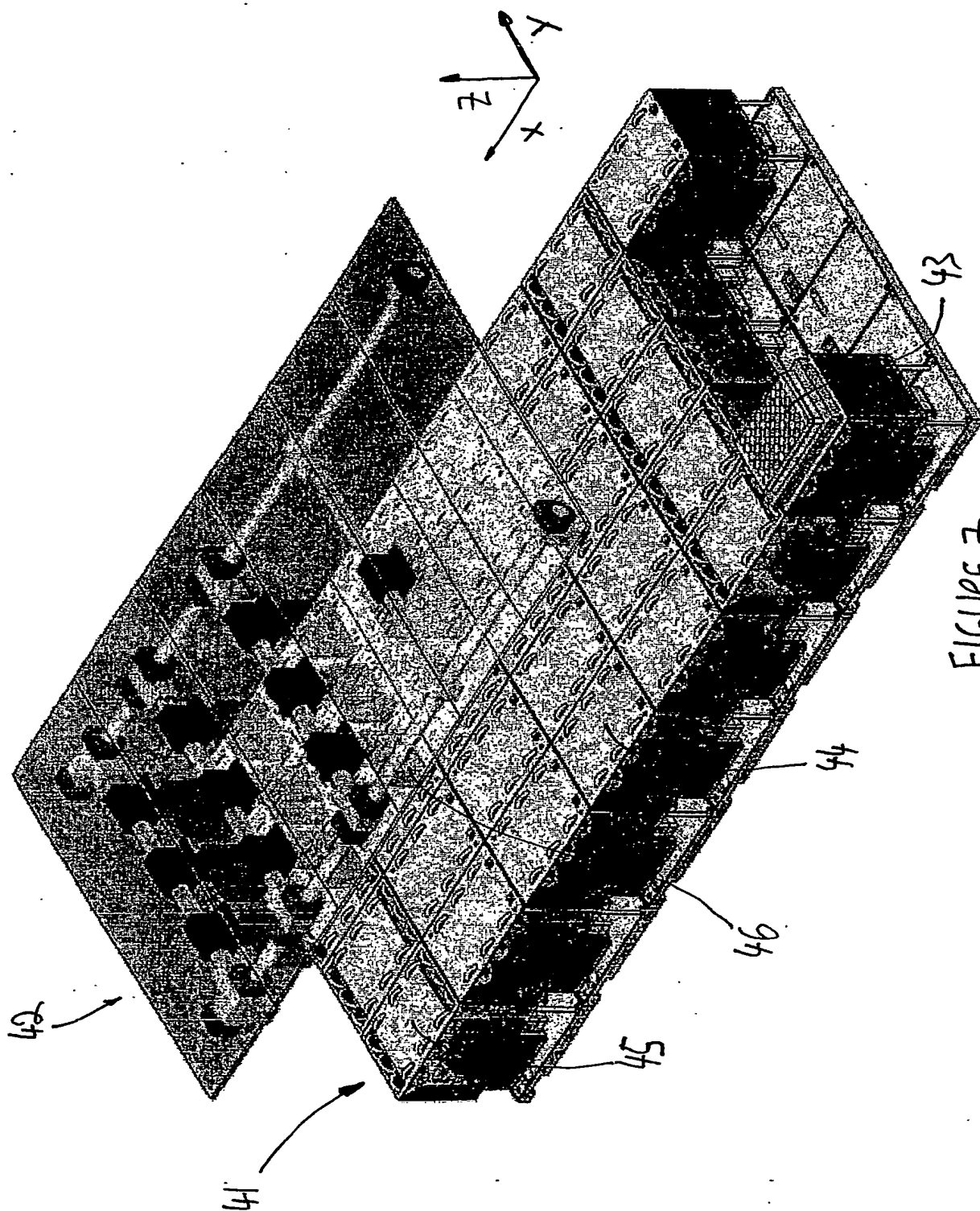


FIGURE 7

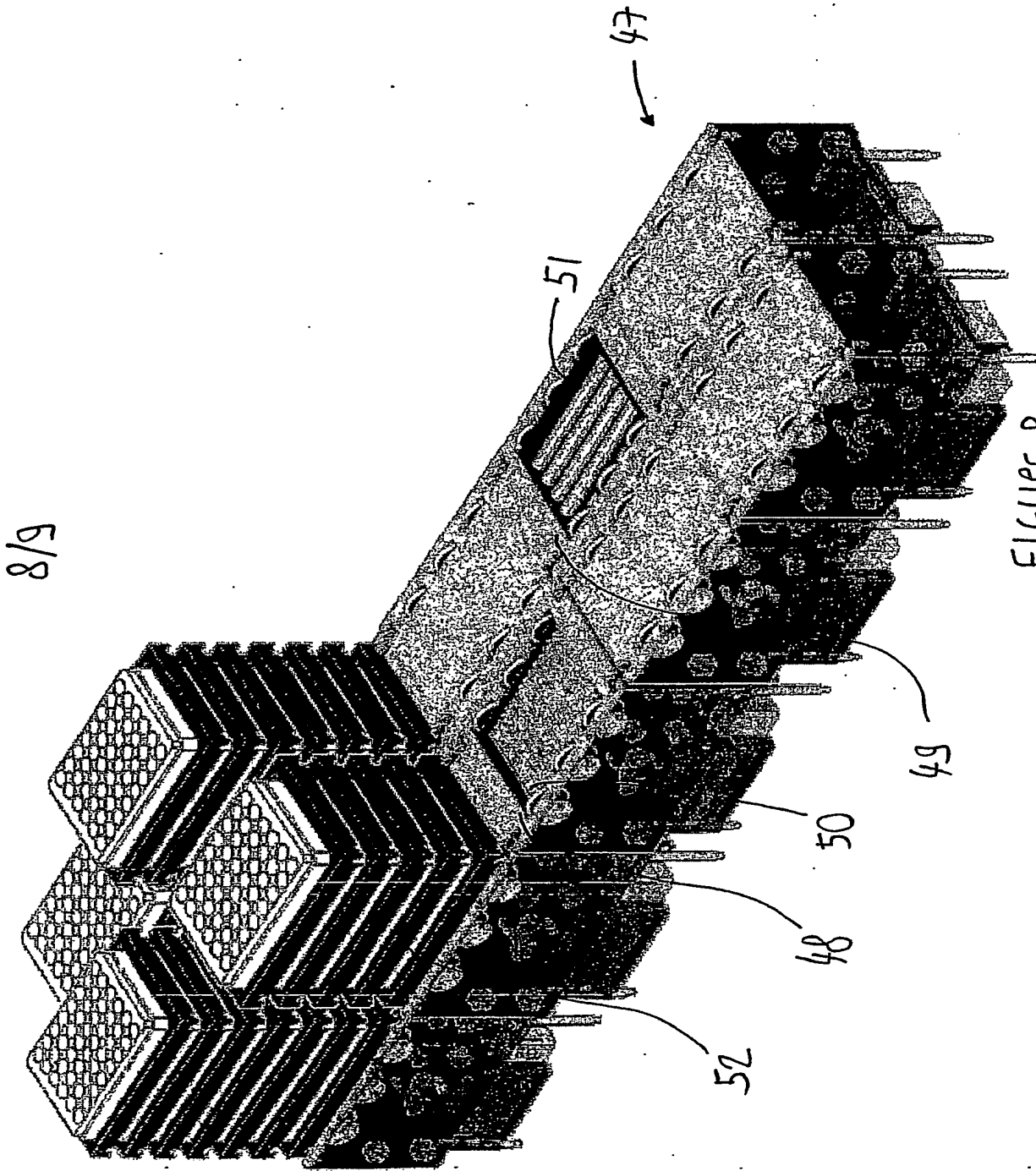


FIGURE 8

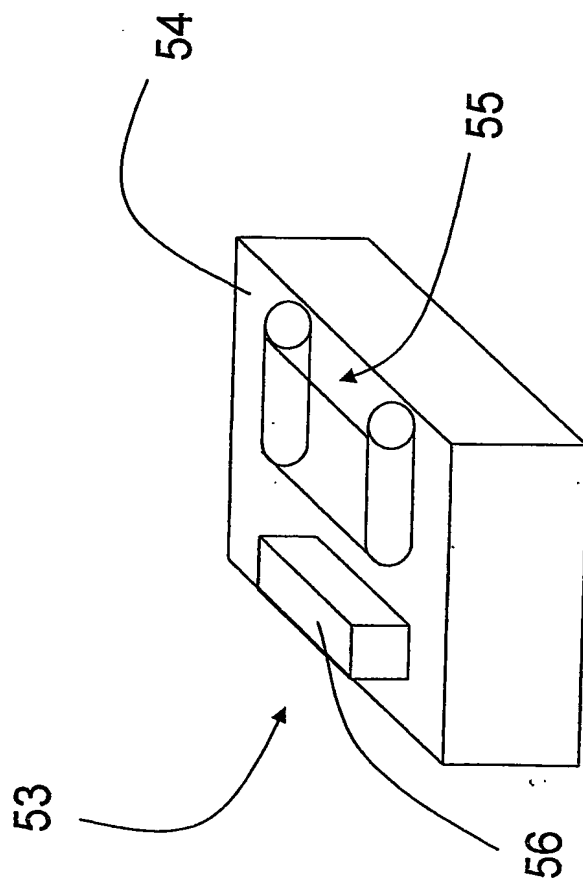


FIGURE 9



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